I claim:

1. A method for controlling gas cooling in a gas pipeline having a heat exchanger at a compressor station, the method comprising the steps of:

A) obtaining observations of parameters that are characteristic of gas flow through the compressor station under a set of operating conditions having a corresponding energy cost;

B) from the observations of step A, determining a balance between gas cooling and heat exchanger gas pressure loss that results in an improvement of energy savings by comparison with the energy cost of the set of operating conditions; and

C) operating a bypass valve on the gas pipeline to divert an amount of gas into the heat exchanger that achieves the balance determined in step B.

2. The method of claim 1 in which the method steps A and B are carried out in a controller operably connected to the bypass valve.

3. The method of claim 1 in which method step B uses an algorithm derived from a mathematical model of the heat exchanger, compressor station and gas pipeline.

4. The method of claim 1 in which the determination of step B results in optimization of energy savings.

5. The method of claim 1 in which the observations of step A comprise gas temperature at the inlet of the heat exchanger, gas temperature at the outlet of the heat exchanger, ambient air temperature and pressure, gas temperature downstream of heat exchanger piping and heat exchanger bypass piping junction, the heat exchanger bypass valve position (i.e. degree of opening), gas pressure at the inlet of the heat exchanger, gas pressure loss across the heat exchanger, gas pressure loss across the heat exchanger gas flow meter, gas pressure loss across the station gas flow meter, gas pressure at the station gas flow meter, actual (double redundant) gas flow rate through the heat exchanger, heat exchanger bypass valve and compressor station, and heat exchanger fouling.

6. The method of claim 1 in which the observations of step A comprise gas temperature at the inlet of the heat exchanger, gas temperature at the outlet of the heat exchanger, ambient air temperature and pressure, gas temperature downstream of heat exchanger piping and heat exchanger bypass piping junction, the heat exchanger bypass valve position (i.e. degree of opening), gas pressure at the inlet of the heat exchanger, gas pressure loss across the heat exchanger, gas pressure loss across the station gas flow meter, gas pressure at the station gas flow meter, actual (redundant) gas flow rate through the heat exchanger, heat exchanger bypass valve and compressor station, and heat exchanger fouling.

7. The method of claim 1 in which the observations of step A comprise gas temperature at the inlet of the heat exchanger, gas temperature at the outlet of the heat exchanger, ambient air temperature and pressure, gas temperature downstream of heat exchanger piping and heat exchanger bypass piping junction, the heat exchanger bypass valve position (i.e. degree of opening), gas pressure at the inlet of the heat exchanger, gas pressure loss across the heat exchanger, gas pressure loss across the heat exchanger gas flow meter, actual (redundant) gas flow rate through the heat exchanger, heat exchanger bypass valve and compressor station, and heat exchanger fouling.

8. The method of claim 1 in which the observations of step A comprise gas temperature at the inlet of the heat exchanger, gas temperature at the outlet of the heat exchanger, ambient air temperature and pressure, gas temperature downstream of heat exchanger piping and heat exchanger bypass piping junction, the heat exchanger bypass valve position (i.e. degree of opening), gas pressure at the inlet of the heat exchanger, gas pressure loss across the heat exchanger, actual gas flow rate through the heat exchanger, heat exchanger bypass valve and compressor station, and heat exchanger fouling.

9. The method of claim 1 in which the observations of step A comprise gas temperature at the inlet of the heat exchanger, gas temperature at the outlet of the heat exchanger, ambient air temperature and pressure, gas temperature downstream of heat exchanger piping and heat exchanger bypass piping junction, gas pressure at the inlet of the heat exchanger, gas pressure loss across the heat exchanger, gas pressure loss across the station gas flow meter, gas pressure at the station gas

flow meter, actual gas flow rate through the heat exchanger, heat exchanger bypass valve and compressor station, and heat exchanger fouling.

10. The method of claim 1 in which the observations of step A comprise gas temperature at the inlet of the heat exchanger, gas temperature at the outlet of the heat exchanger, ambient air temperature and pressure, gas temperature downstream of heat exchanger piping and heat exchanger bypass piping junction, gas pressure at the inlet of the heat exchanger, gas pressure loss across the heat exchanger, gas pressure loss across the heat exchanger gas flow meter, actual gas flow rate through the heat exchanger, heat exchanger bypass valve and compressor station, and heat exchanger fouling.

11. The method of claim 1 in which the observations of step A comprise gas temperature at the inlet of the heat exchanger, gas temperature at the outlet of the heat exchanger, ambient air temperature and pressure, gas temperature downstream of heat exchanger piping and heat exchanger bypass piping junction, gas pressure at the inlet of the heat exchanger, gas pressure loss across the heat exchanger, and estimated gas flow rate through the heat exchanger, heat exchanger bypass valve and compressor station.

12. The method of claim 1 in which the observations of step A comprise gas temperature at the inlet of the heat exchanger, gas temperature at the outlet of the heat exchanger, ambient air temperature and pressure, the heat exchanger bypass valve position (i.e. degree of opening), gas pressure at the inlet of the heat exchanger, gas pressure loss across the heat exchanger, gas pressure loss across the station gas flow meter, gas pressure at the station gas flow meter, actual gas flow rate through the heat exchanger, heat exchanger bypass valve and compressor station, and heat exchanger fouling.

13. The method of claim 1 in which the observations of step A comprise gas temperature at the inlet of the heat exchanger, gas temperature at the outlet of the heat exchanger, ambient air temperature and pressure, the heat exchanger bypass valve position (i.e. degree of opening), gas pressure at the inlet of the heat exchanger, gas pressure loss across the heat exchanger, gas pressure

loss across the heat exchanger gas flow meter, actual gas flow rate through the heat exchanger, heat exchanger bypass valve and compressor station, and heat exchanger fouling.

14. The method of claim 1 in which the observations of step A comprise gas temperature at the inlet of the heat exchanger, gas temperature at the outlet of the heat exchanger, ambient air temperature and pressure, the heat exchanger bypass valve position (i.e. degree of opening), gas pressure at the inlet of the heat exchanger, gas pressure loss across the heat exchanger, estimated gas flow rate through the heat exchanger and compressor station, and actual gas flow rate through the heat exchanger bypass valve.

15. The method of claim 1 in which the observations of step A comprise gas temperature at the inlet of the heat exchanger, gas temperature at the outlet of the heat exchanger, ambient air temperature and pressure, gas pressure at the inlet of the heat exchanger, gas pressure loss across the heat exchanger, estimated gas flow rate through the heat exchanger and periodic estimated gas flow through the heat exchanger bypass valve, and compressor station.

16. The method of claim 1 further comprising the steps of:
finding the gas flow rate through the heat exchanger; and
adjusting the determination of step B for the gas flow rate through the heat exchanger

17. The method of claim 1 further comprising the steps of:
finding the gas flow rate through the bypass valve; and
adjusting the determination of step B for the gas flow rate through bypass valve.

18. The method of claim 1 further comprising the steps of:
finding the gas flow rate through the compressor station; and
adjusting the determination of step B for the gas flow rate through the compressor station.

19. The method of claim 1 further comprising the steps of:
finding the expected pressure differential across the heat exchanger at a level of gas flow rate;

finding the actual pressure differential across the heat exchanger at a level of gas flow rate;

finding a relationship between the actual pressure differential and expected pressure differential across the heat exchanger at the level of gas flow rate; and

finding the degree of internal fouling of the heat exchanger from the relationship found in the preceding step.

20. The method of claim 19 further comprising the step of:

adjusting the determination of step B for the gas flow rate through the heat exchanger.

21. The method of claim 19 further comprising the step of:

recording the increase in pressure differential across the heat exchanger tubes for future maintenance action.

22. The method of claim 1 further comprising the steps of:

finding the original dirty overall heat transfer coefficient for the heat exchanger at a level of cooling and gas flow rate;

finding the original clean overall heat transfer coefficient for the heat exchanger at a level of cooling and gas flow rate;

finding a relationship between the original dirty and clean overall heat transfer coefficient at the level of cooling and gas flow rate; and

finding the original fouling resistance for the heat exchanger from the relationship found in the preceding step.

23. The method of claim 1 further comprising the steps of:

finding the actual current dirty overall heat transfer coefficient for the heat exchanger at a level of cooling and gas flow rate;

finding the actual current clean overall heat transfer coefficient for the heat exchanger at a level of cooling and gas flow rate;

finding a relationship between the actual current dirty and clean overall heat transfer coefficient at a level of cooling and gas flow rate; and

finding the actual current fouling resistance for the heat exchanger from the relationship found in the preceding step.

24. The method of claim 19 further comprising the steps of:

finding a relationship between the original fouling resistance and actual current fouling resistance for the heat exchanger at level of cooling and gas flow rate; and

finding the degree of internal and/or external fouling of the heat exchanger from the relationship found in the preceding step.

25. The method of claim 24 further comprising the step of:

adjusting the determination of step B for the gas flow rate through the heat exchanger.

26. The method of claim 24 further comprising the step of:

recording the increase in internal and/or external fouling of the heat exchanger tubes for future maintenance action.

27. Apparatus for controlling gas cooling in a gas pipeline, the apparatus comprising:

a compressor station through which a gas pipeline flows gas;

a heat exchanger on a cooling circuit attached to the gas pipeline;

a bypass valve on a line parallel to the cooling circuit;

transmitters in the compressor station for producing observations of operating parameters of the compressor station;

a controller operably connected to the bypass valve and to the transmitters, the controller incorporating a model of flow of gas through a heat exchanger at a compressor station and being configured to determine, from the model and the observations, a balance between gas cooling and heat exchanger pressure loss that results in an improvement of energy savings; and

the controller having output for controlling operation of the bypass valve on the gas pipeline to divert gas into the heat exchanger.

28. A method for controlling gas cooling in a gas pipeline having a heat exchanger at a compressor station, the gas pipeline having a bypass valve for controlling the amount of gas diverted from the gas pipeline into the heat exchanger, the method comprising the steps of:

A) obtaining observations of parameters that are characteristic of gas flow through the compressor station under a set of operating conditions having a corresponding energy cost, which observations comprise gas temperature at the inlet of the heat exchanger, gas temperature at the outlet of the heat exchanger, ambient air temperature and pressure, gas temperature downstream of heat exchanger piping and heat exchanger bypass piping junction and/or the heat exchanger bypass valve position (i.e. degree of opening), gas pressure at the inlet of the heat exchanger, gas pressure loss across the heat exchanger, gas pressure loss across the heat exchanger gas flow meter and/or gas pressure loss across the station gas flow meter and gas pressure at the station gas flow meter, gas flow rate through the heat exchanger, heat exchanger bypass valve and compressor station, and heat exchanger fouling.

B) from the observations of step A, determining, in a controller operably connected to the bypass valve, a balance between gas cooling and heat exchanger pressure loss that results in an improvement of energy savings by comparison with the energy cost of the set of operating conditions, which determination is carried out using an algorithm derived from a mathematical model of the heat exchanger, compressor station(s) and gas pipeline; and

C) operating the bypass valve on the gas pipeline to divert an amount of gas into the heat exchanger that achieves the balance determined in step B.

29. The method of claim 28 in which the determination of step B results in optimization of energy savings.